

Approval



TO :  
DATE : Apr. 16, 2012.

**SAMSUNG TFT-LCD**  
**MODEL NO : LTN156AT20-W**

NOTE : Extension code [ -W ]  
→ LTN156AT20-W  
Surface type [ **Glare** ]

Any modification of Spec is not allowed without Samsung's permission

**Application engineering part, LCD Division**  
**Samsung Display Co., Ltd.**

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## SPEC REVISION HISTORY

## Approval

[illegible]

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## GENERAL DESCRIPTION

### DESCRIPTION

LTN156AT20- W is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a backlight system. The resolution of a 15.6" contains 1366 x 768 pixels and can display up to 262,144 colors. 6 O'clock direction is the Optimum viewing angle.

### FEATURES

- Thin and light weight
- High contrast ratio, high aperture structure
- 1366 x 768 pixels resolution (16:9)
- Fast Response Time
- Low power consumption
- LED BLU Structure
- DE (Data enable) only mode
- 3.3V LVDS Interface
- On board EDID chip
- Pb-free product
- Advanced Power Saving function

### APPLICATIONS

- Notebook PC
- If the usage of this product is not for PC application, but for others, please contact Samsung

## GENERAL INFORMATION

| Item              | Specification                             | Unit  | Note   |
|-------------------|-------------------------------------------|-------|--------|
| Display area      | 344.232 (H) x 193.536 (V) (15.6"diagonal) | mm    |        |
| Driver element    | a-Si TFT active matrix                    |       |        |
| Display colors    | 262,144                                   |       |        |
| Number of pixel   | 1366 x 768                                | pixel | 16 : 9 |
| Pixel arrangement | RGB vertical stripe                       |       |        |
| Pixel pitch       | 0.252 (H) x 0.252 (V) (TYP.)              | mm    |        |
| Display Mode      | Normally white                            |       |        |
| Surface treatment | Haze 0, Hardness 3H                       |       | Glare  |

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## Mechanical Information

| Item        |                | Min.  | Typ.  | Max.  | Unit | Note            |
|-------------|----------------|-------|-------|-------|------|-----------------|
| Module size | Horizontal (H) | 359.0 | 359.5 | 360.0 | mm   |                 |
|             | Vertical (V)   | 223.3 | 223.8 | 224.3 | mm   | Flange ~ PCB    |
|             |                | 206.1 | 206.6 | 207.1 | mm   | Module ~ Module |
|             | Depth (D)      | -     | -     | 3.8   | mm   | (1)             |
| Weight      |                | -     | -     | 440   | g    |                 |

Note (1) Measurement condition of outline dimension

. Equipment : Vernier Calipers

. Push Force : 750g · f (minimum)

## 1. ABSOLUTE MAXIMUM RATINGS

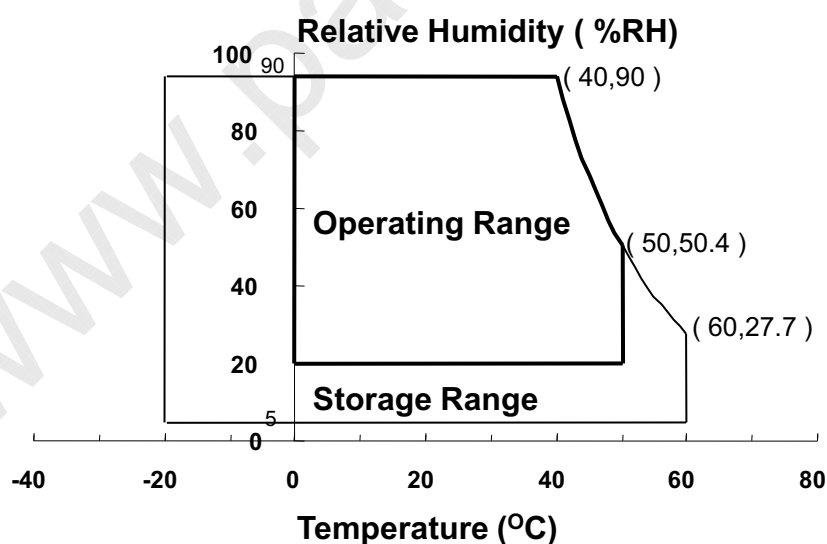
## 1.1 ENVIRONMENTAL ABSOLUTE RATINGS

| Item                                                  | Symbol | Min. | Max. | Unit | Note    |
|-------------------------------------------------------|--------|------|------|------|---------|
| Storage temperate                                     | TSTG   | -20  | 60   | °C   | (1)     |
| Operating temperate<br>(Temperature of glass surface) | TOPR   | 0    | 50   | °C   | (1)     |
| Shock ( non-operating )                               | Snop   | -    | 240  | G    | (2),(4) |
| Vibration (non-operating)                             | Vnop   | -    | 2.41 | G    | (3),(4) |

Note (1) Temperature and relative humidity range are shown in the figure below.

95 % RH Max. ( $40^{\circ}\text{C} \geq T_a$ )

Maximum wet - bulb temperature at  $39^{\circ}\text{C}$  or less. ( $T_a > 40^{\circ}\text{C}$ ) No condensation



(2) 2ms, half sine wave, one time for  $\pm X$ ,  $\pm Y$ ,  $\pm Z$ .

(3) 5 - 500 Hz, random vibration, 30min for X, Y, Z.

(4) At testing Vibration and Shock, the fixture in holding the Module to be tested have to be hard and rigid enough so that the Module would not be twisted or bent by the fixture.

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## 1.2 ELECTRICAL ABSOLUTE RATINGS

## (1) TFT LCD MODULE

 $V_{DD} = 3.3V$ ,  $V_{SS} = GND = 0V$ 

| Item                 | Symbol   | Min.           | Max.           | Unit | Note |
|----------------------|----------|----------------|----------------|------|------|
| Power Supply Voltage | $V_{DD}$ | $V_{DD} - 0.3$ | $V_{DD} + 0.3$ | V    | (1)  |
| Logic Input Voltage  | $V_{DD}$ | $V_{DD} - 0.3$ | $V_{DD} + 0.3$ | V    | (1)  |

Note (1) Within  $T_a$  ( $25 \pm 2^\circ C$ )

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## 2. OPTICAL CHARACTERISTICS

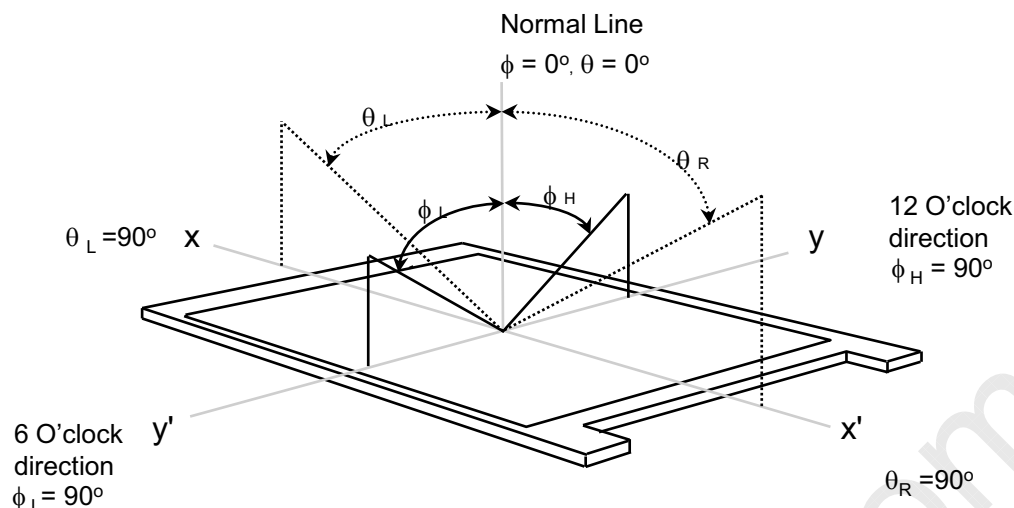
The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (5).  
Measuring equipment : TOPCON SR-3

\* Ta = 25 ± 2 °C, V<sub>DD</sub>=3.3V, fv= 60Hz, f<sub>DCLK</sub>=72.33 MHz, IL = 25mA

| Item                                        |       | Symbol             | Condition                                                | Min.  | Typ.  | Max   | Unit              | Note                                 |
|---------------------------------------------|-------|--------------------|----------------------------------------------------------|-------|-------|-------|-------------------|--------------------------------------|
| Contrast Ratio<br>(5 Points)                |       | CR                 | Normal<br>Viewing<br>Angle<br>$\phi = 0$<br>$\theta = 0$ | 400   | 500   | -     | -                 | (1), (2),<br>(5)                     |
| Response Time at Ta<br>( Rising + Falling ) |       | T <sub>RT</sub>    |                                                          | -     | 16    | 25    | msec              | (1), (3)                             |
| Average Luminance<br>of White (5 Points)    |       | Y <sub>L,AVE</sub> |                                                          | 170   | 200   | -     | cd/m <sup>2</sup> | I <sub>L</sub> =<br>25mA<br>(1), (4) |
| Color<br>Chromaticity<br>( CIE )            | Red   | R <sub>X</sub>     |                                                          | 0.540 | 0.570 | 0.600 | -                 | (1), (5)<br>SR-3                     |
|                                             |       | R <sub>Y</sub>     |                                                          | 0.310 | 0.340 | 0.370 |                   |                                      |
|                                             | Green | G <sub>X</sub>     |                                                          | 0.300 | 0.330 | 0.360 |                   |                                      |
|                                             |       | G <sub>Y</sub>     |                                                          | 0.530 | 0.560 | 0.590 |                   |                                      |
|                                             | Blue  | B <sub>X</sub>     |                                                          | 0.130 | 0.160 | 0.190 |                   |                                      |
|                                             |       | B <sub>Y</sub>     |                                                          | 0.105 | 0.135 | 0.165 |                   |                                      |
|                                             | White | W <sub>X</sub>     |                                                          | 0.283 | 0.313 | 0.343 |                   |                                      |
|                                             |       | W <sub>Y</sub>     | 0.299                                                    | 0.329 | 0.359 |       |                   |                                      |
| Viewing<br>Angle                            | Hor.  | $\theta_L$         | CR ≥ 10                                                  | 40    | 45    | -     | Degrees           | (1), (5)<br>SR-3                     |
|                                             |       | $\theta_R$         |                                                          | 40    | 45    | -     |                   |                                      |
|                                             | Ver.  | $\phi_H$           |                                                          | 10    | 15    | -     |                   |                                      |
|                                             |       | $\phi_L$           |                                                          | 30    | 35    | -     |                   |                                      |
| Color Gamut                                 |       |                    |                                                          | -     | 45    | -     | %                 |                                      |
| 13 Points<br>White Variation                |       | $\delta_L$         |                                                          | -     | -     | 1.7   | -                 | (6)                                  |

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Note 1) Definition of Viewing Angle : Viewing angle range( $10 \leq C/R$ )

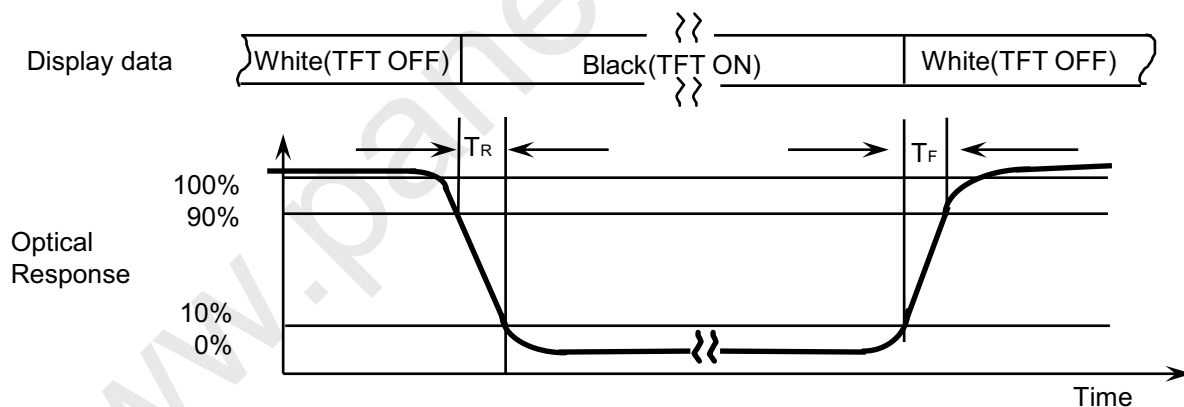


Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at 5 points (33, 55, 77, 37, 73)

$$CR = \frac{CR(33) + CR(55) + CR(77) + CR(37) + CR(73)}{5}$$

Points : 33, 55, 77, 37, 73 at the figure of Note (6).

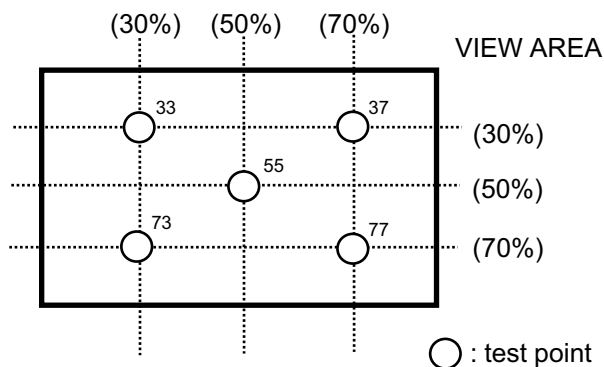
Note 3) Definition of Response time :



Note 4) Definition of Average Luminance of White : measure the luminance of white at 5 points.

Average Luminance of White ( $Y_{L,AVE}$ )

$$Y_{L,AVE} = \frac{Y_{L33} + Y_{L55} + Y_{L77} + Y_{L37} + Y_{L73}}{5}$$



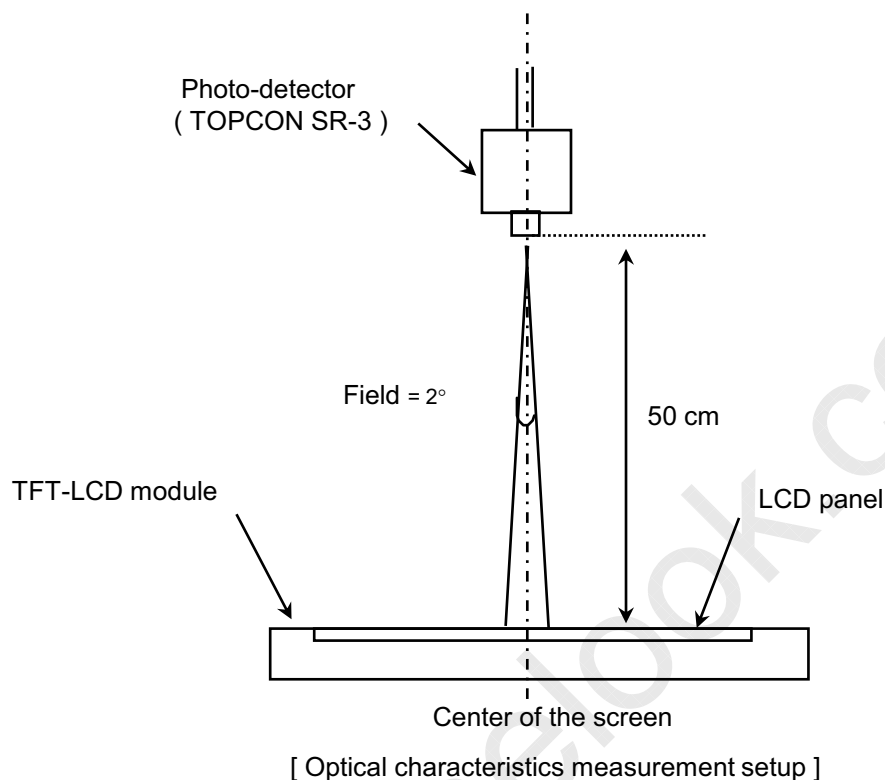
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Note 5) After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the backlight. This should be measured in the center of screen.

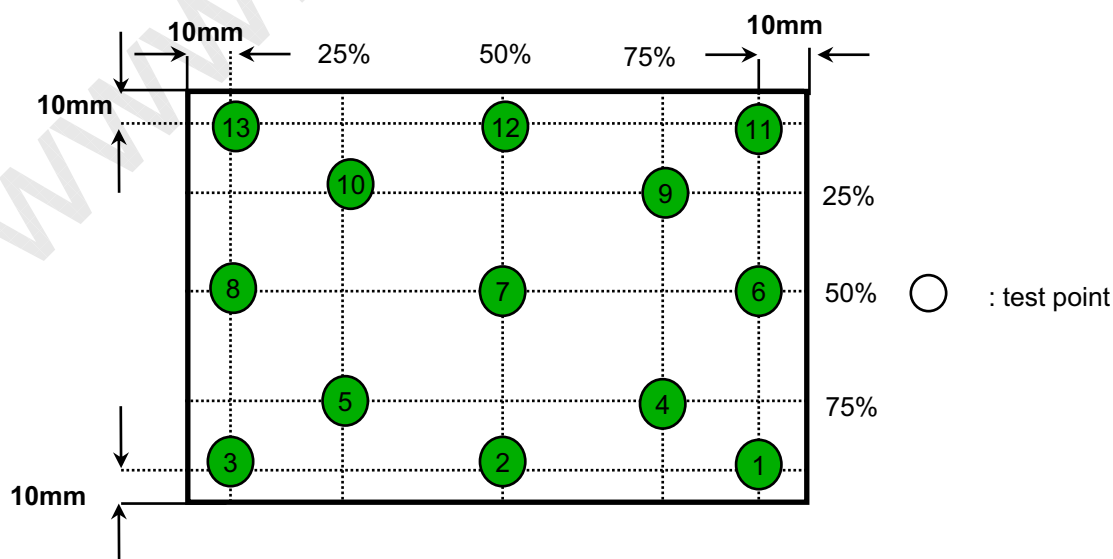
LED current : 25.0mA

Environment condition :  $T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$



Note 6) Definition of 13 points white variation ( $\delta L$ ), [ ① ~ ⑬ ]

$$\delta L = \frac{\text{Maximum luminance of 13 points}}{\text{Minimum luminance of 13 points}}$$



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### 3. ELECTRICAL CHARACTERISTICS

#### 3.1 TFT LCD MODULE

 $T_a = 25 \pm 2^\circ\text{C}$ 

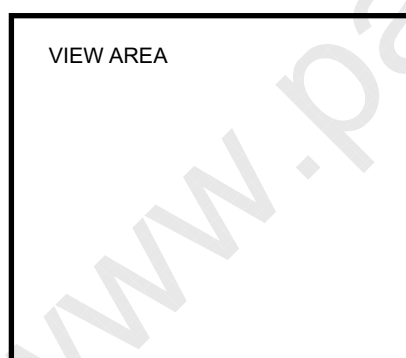
| Item                                                   |          | Symbol            | Min. | Typ.  | Max.  | Unit | Note                    |
|--------------------------------------------------------|----------|-------------------|------|-------|-------|------|-------------------------|
| Voltage of Power Supply                                |          | V <sub>CC</sub>   | 3.0  | 3.3   | 3.6   | V    |                         |
| Differential Input Voltage for LVDS Receiver Threshold | High     | V <sub>IH</sub>   | -    | -     | +100  | mV   | V <sub>CM</sub> = +1.2V |
|                                                        | Low      | V <sub>IL</sub>   | -100 | -     | -     | mV   |                         |
| Vsync Frequency                                        |          | f <sub>v</sub>    | -    | 60    | -     | Hz   |                         |
| Main Frequency                                         |          | f <sub>DCLK</sub> | 66.3 | 72.33 | 83.88 | MHz  |                         |
| Rush Current                                           |          | I <sub>RUSH</sub> | -    | -     | 1.5   | A    | (4)                     |
| Current of Power Supply                                | White    | I <sub>DD</sub>   | -    | 220   | -     | mA   | (2),(3)*a               |
|                                                        | Mosaic   |                   | -    | 220   | -     | mA   | (2),(3)*b               |
|                                                        | Black    |                   | -    | 220   | -     | mA   | (2),(3)*c               |
|                                                        | V.stripe |                   | -    | 400   | 450   | mA   | (2),(3)*d               |

Note (1) Display data pins and timing signal pins should be connected.( GND = 0V )

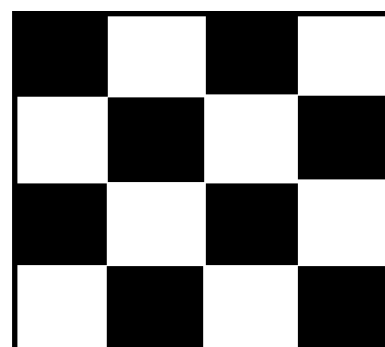
(2) f<sub>v</sub> = 60Hz, f<sub>DCLK</sub> = 72.33 MHz, V<sub>DD</sub> = 3.3V , DC Current.

(3) Power dissipation pattern

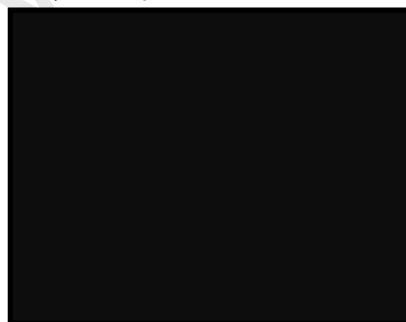
\*a) White Pattern



\*b) Mosaic Pattern

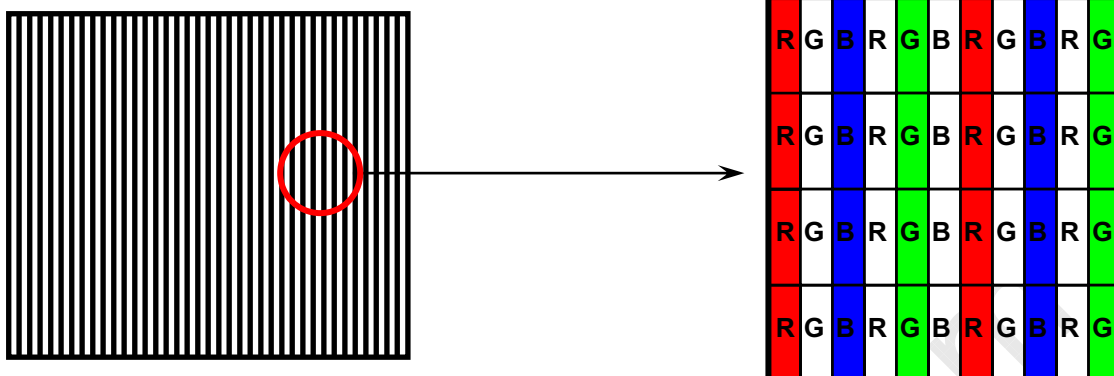


\*C) Black pattern

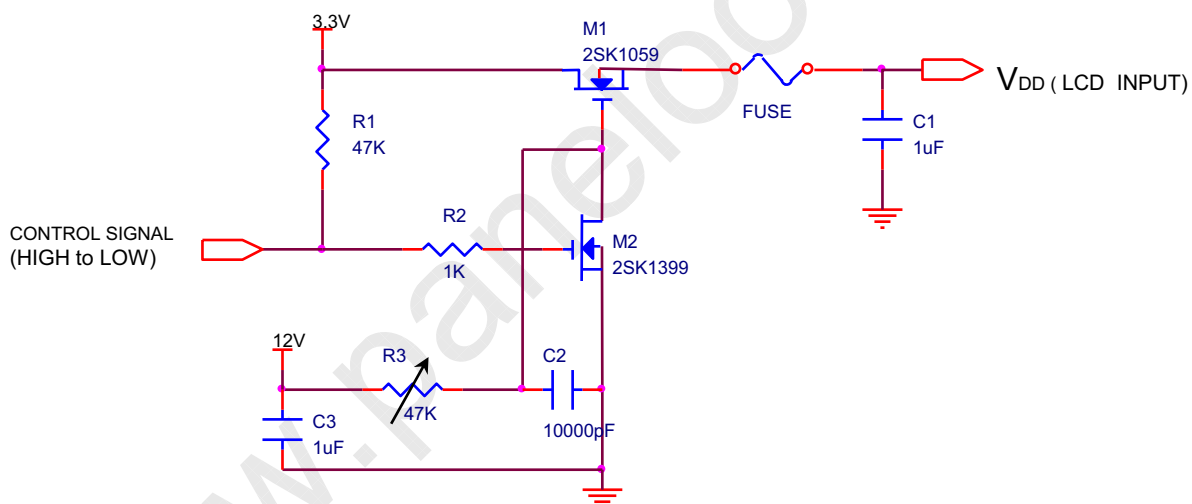


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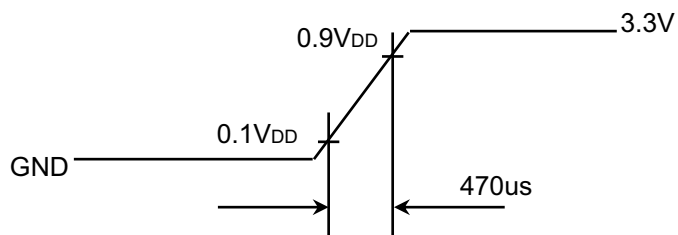
## \*d) 1dot Vertical stripe pattern



## 4) Rush current measurement condition



V<sub>DD</sub> rising time is 470us



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## 3.2 BACK-LIGHT UNIT

Ta= 25 ± 2 °C

| Item                | Symbol | Min.  | Typ. | Max. | Unit | Note |
|---------------------|--------|-------|------|------|------|------|
| LED Forward Current | IF     | -     | 25.0 | -    | mA   |      |
| LED Forward Voltage | VF     | 3.0   | 3.2  | 3.4  | V    |      |
| LED counts          |        |       | 27   | -    | ea   |      |
| Operating Life Time | Hr     | 12000 | -    | -    | Hour | (1)  |

Note (1) Life time (Hr) of LEDs can be defined as the time in which it continues to operate under the condition Ta= 25 ± 2 °C and IF = 25 mArms until one of the following event occurs.  
When the brightness becomes 50% or lower than the original.

## 3.3 LED Driver

- LED Driver Manufacturer : Richtek RT8510

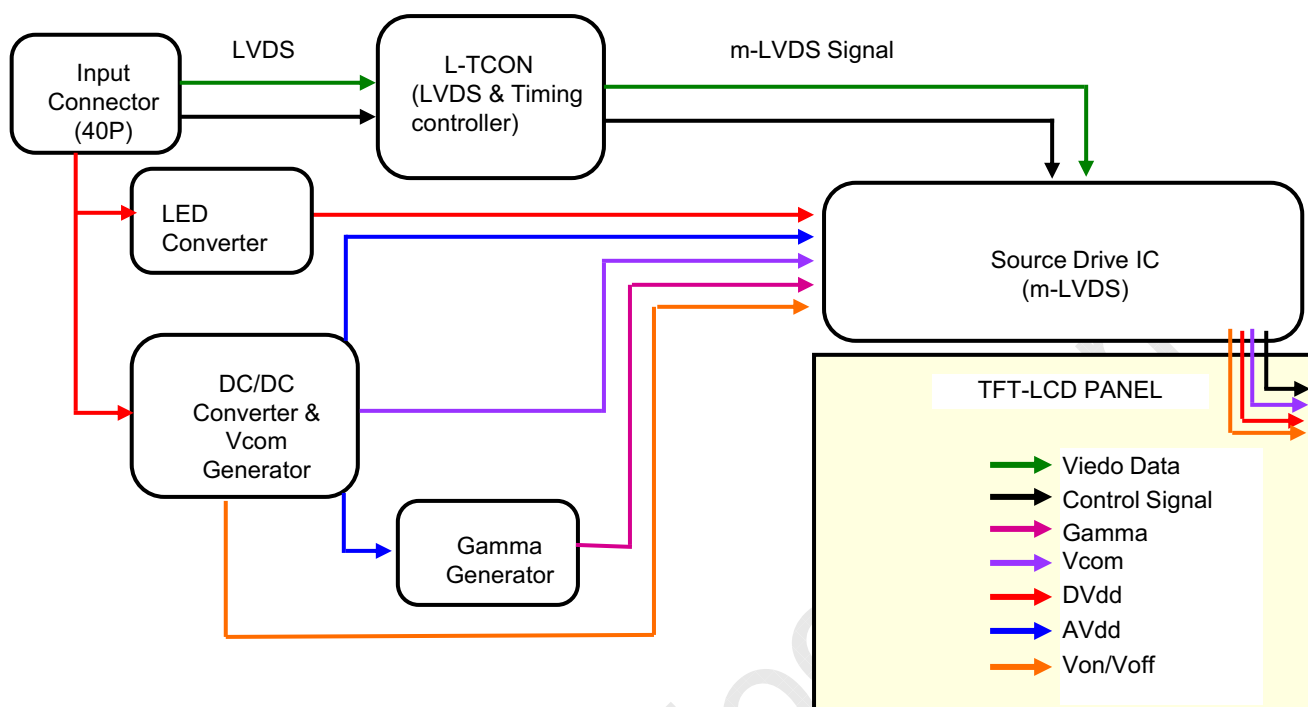
Ta= 25 ± 2 °C

| Item-                                         | Symbol            | Min. | Typ. | Max. | Unit | Note                     |
|-----------------------------------------------|-------------------|------|------|------|------|--------------------------|
| Input Voltage                                 | V <sub>in</sub>   | 7    | 12   | 21   | V    | -                        |
| PWM Control Duty Ratio                        | D                 | 1    | -    | 100  | %    | PWM freq : 120Hz ~ 1KHz  |
|                                               |                   | 5    | -    |      |      | PWM freq : 1KHz ~ 10KHz  |
|                                               |                   | 10   | -    |      |      | PWM freq : 10KHz ~ 30KHz |
| External PWM Dimming Control Frequency (BLIM) | F <sub>BLIM</sub> | 0.2  | 1    | 30   | kHz  | -                        |

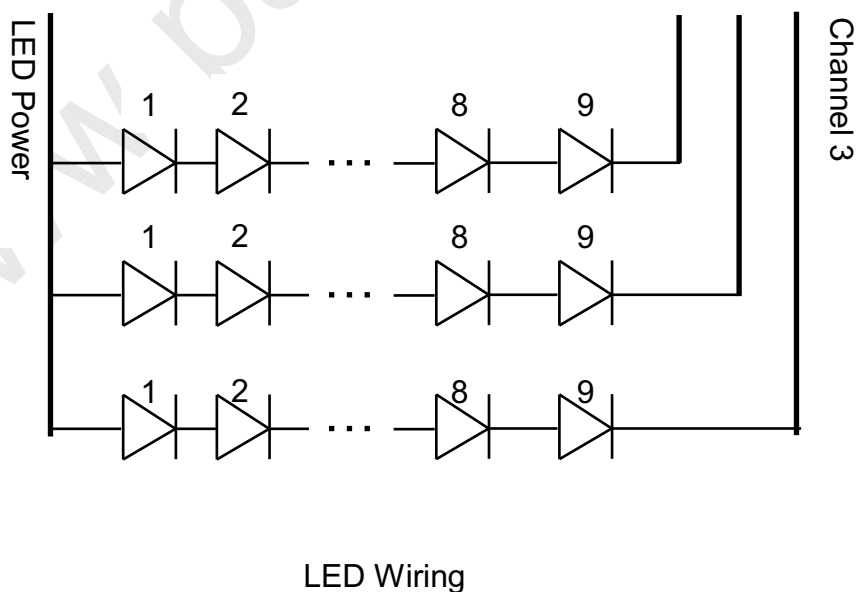
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## 4. BLOCK DIAGRAM

### 4.1 TFT LCD Module



### 4.2 LED placement structure

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## 5. INPUT TERMINAL PIN ASSIGNMENT

### 5.1. Input Signal & Power (LVDS, Connector : Molex 104062-4017 or I-PEX 20455-040E-12)

| Pin     | Symbol   | Function                                         |
|---------|----------|--------------------------------------------------|
| 1       | NC       | no connect                                       |
| 2~3     | VDD      | Logic power 3.3V (Panel logic, BL logic)         |
| 4       | VEDID    | EDID 3.3V power                                  |
| 5       | WPN      | EDID writing protection                          |
| 6       | CLK      | EDID clock                                       |
| 7       | DATA     | EDID data                                        |
| 8       | RIN0-    | - LVDS differential data input (R0-R5, G0)       |
| 9       | RIN0+    | + LVDS differential data input (R0-R5, G0)       |
| 10      | GND      | Ground                                           |
| 11      | RIN1-    | - LVDS differential data input (G1-G5, B0-B1)    |
| 12      | RIN1+    | + LVDS differential data input (G1-G5, B0-B1)    |
| 13      | GND      | Ground                                           |
| 14      | RIN2-    | - LVDS differential data input (B2-B5,HS,VS, DE) |
| 15      | RIN2+    | + LVDS differential data input (B2-B5,HS,VS, DE) |
| 16      | GND      | Ground                                           |
| 17      | CLK-     | - LVDS differential clock input                  |
| 18      | CLK+     | + LVDS differential clock input                  |
| 19      | NC       | no connect                                       |
| 20 ~ 21 | NC       | no connect                                       |
| 22      | GND      | Ground                                           |
| 23 ~ 24 | NC       | no connect                                       |
| 25      | GND      | Ground                                           |
| 26 ~ 27 | NC       | no connect                                       |
| 28      | GND      | Ground                                           |
| 29 ~ 30 | NC       | no connect                                       |
| 31 ~ 33 | VLED_GND | LED Ground                                       |
| 34      | NC       | no connect                                       |
| 35      | S_PWMIN  | System PWM Signal Input                          |
| 36      | BL_ON    | LED enable pin (+3.3V input, +5V tolerance)      |
| 37      | APS_EN   | Advantage Power saving mode (High enable)        |
| 38~40   | VLED     | LED Power Supply 7V-21V                          |

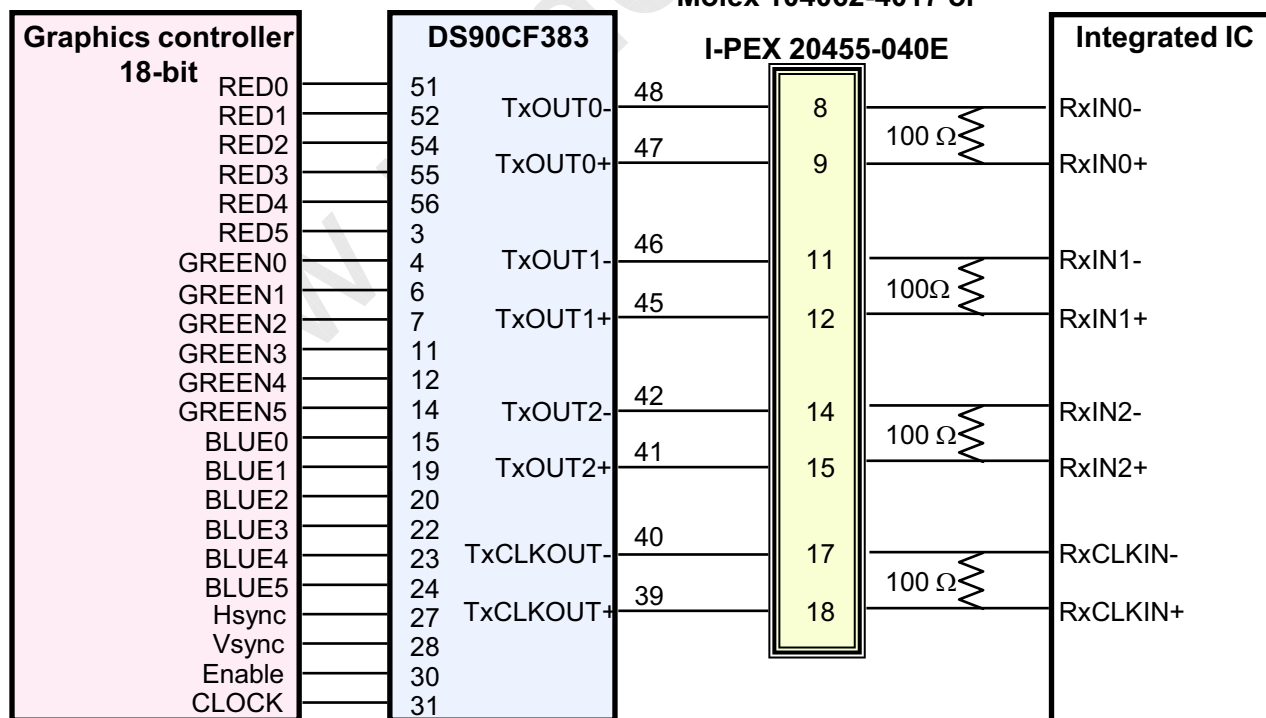
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## 5.2 LVDS Interface : Transmitter DS90CF363 or Compatible

| Pin No. | Name   | RGB Signal | Pin No. | Name    | RGB Signal |
|---------|--------|------------|---------|---------|------------|
| 51      | TxIN0  | R0         | 14      | TxIN14  | G5         |
| 52      | TxIN1  | R1         | 15      | TxIN15  | B0         |
| 54      | TxIN2  | R2         | 19      | TxIN18  | B1         |
| 55      | TxIN3  | R3         | 20      | TxIN19  | B2         |
| 56      | TxIN4  | R4         | 22      | TxIN20  | B3         |
| 3       | TxIN6  | R5         | 23      | TxIN21  | B4         |
| 4       | TxIN7  | G0         | 24      | TxIN22  | B5         |
| 6       | TxIN8  | G1         | 27      | TxIN24  | Hsync      |
| 7       | TxIN9  | G2         | 28      | TxIN25  | Vsync      |
| 11      | TxIN12 | G3         | 30      | TxIN26  | DE         |
| 12      | TxIN13 | G4         | 31      | TxCLKIN | Clock      |

## LVDS INTERFACE

Molex 104062-4017 or

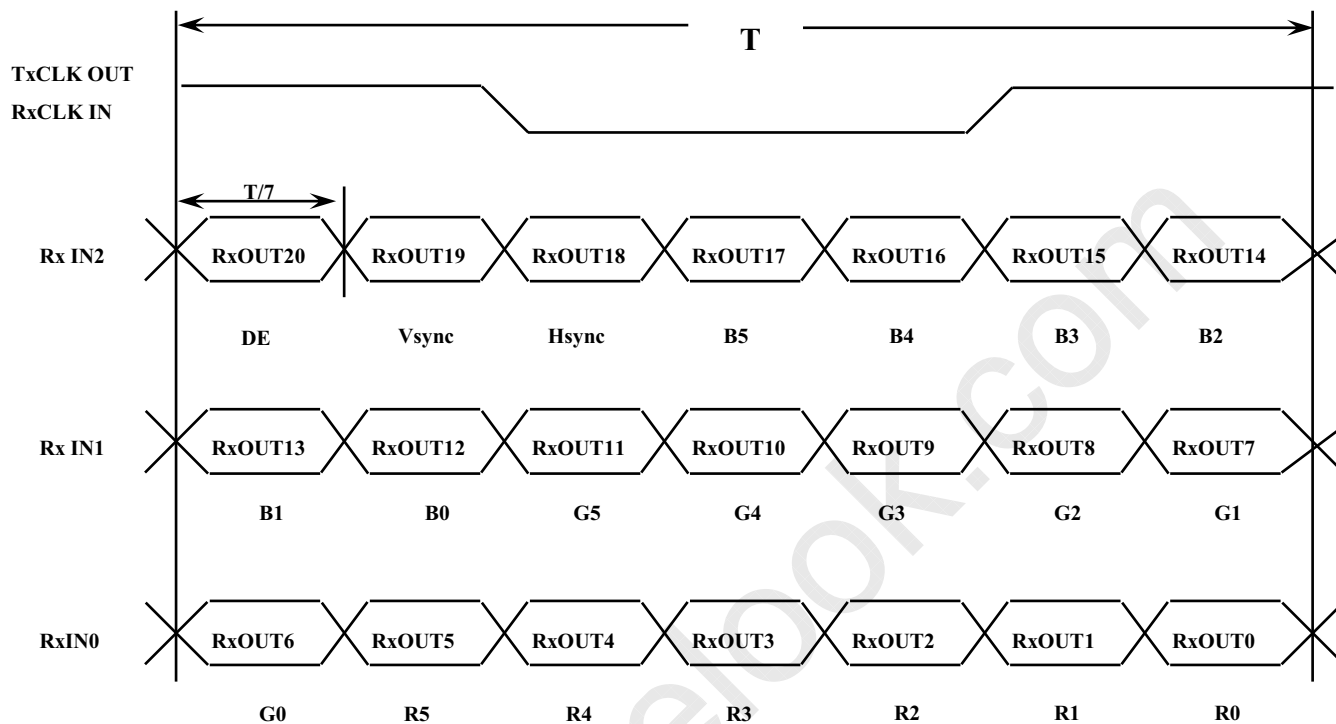


Note : The LCD Module uses a 100ohm resistor between positive and negative lines of each receiver input.

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### 5.3 Timing Diagrams of LVDS For Transmission

#### LVDS Receiver : Integrated T-CON

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## 5.4 Input Signals, Basic Display Colors and Gray Scale of Each Color

| Color               | Display | Data Signal |    |    |    |    |    |       |    |    |    |    |    |      |    |    |    |    | Gray Scale Level |        |
|---------------------|---------|-------------|----|----|----|----|----|-------|----|----|----|----|----|------|----|----|----|----|------------------|--------|
|                     |         | Red         |    |    |    |    |    | Green |    |    |    |    |    | Blue |    |    |    |    |                  |        |
|                     |         | R0          | R1 | R2 | R3 | R4 | R5 | G0    | G1 | G2 | G3 | G4 | G5 | B0   | B1 | B2 | B3 | 45 |                  | B5     |
| Basic Colors        | Black   | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | -      |
|                     | Blue    | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1  | 1                | -      |
|                     | Green   | 0           | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0                | -      |
|                     | Cyan    | 0           | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1  | 1                | -      |
|                     | Red     | 1           | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | -      |
|                     | Magenta | 1           | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1  | 1                | -      |
|                     | Yellow  | 1           | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0                | -      |
|                     | White   | 1           | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1  | 1                | -      |
| Gray Scale Of Red   | Black   | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | R0     |
|                     | Dark    | 1           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | R1     |
|                     | ↑       | 0           | 1  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | R2     |
|                     | :       | :           | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :                | R3~R60 |
|                     | :       | :           | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :                |        |
|                     | ↓       | 1           | 0  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | R61    |
|                     | Light   | 0           | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | R62    |
|                     | Red     | 1           | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | R63    |
| Gray Scale Of Green | Black   | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | G0     |
|                     | Dark    | 0           | 0  | 0  | 0  | 0  | 0  | 1     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | G1     |
|                     | ↑       | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 1  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | G2     |
|                     | :       | :           | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :                | G3~G60 |
|                     | :       | :           | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :                |        |
|                     | ↓       | 0           | 0  | 0  | 0  | 0  | 0  | 1     | 0  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0                | G61    |
|                     | Light   | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 1  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0                | G62    |
|                     | Green   | 0           | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0                | G63    |
| Gray Scale Of Blue  | Black   | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0                | B0     |
|                     | Dark    | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1    | 0  | 0  | 0  | 0  | 0                | B1     |
|                     | ↑       | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 1  | 0  | 0  | 0  | 0                | B2     |
|                     | :       | :           | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :                | B3~B60 |
|                     | :       | :           | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :                |        |
|                     | ↓       | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1    | 0  | 1  | 1  | 1  | 1                | B61    |
|                     | Light   | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0    | 1  | 1  | 1  | 1  | 1                | B62    |
|                     | Blue    | 0           | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1  | 1                | B63    |

Note 1) Definition of gray :

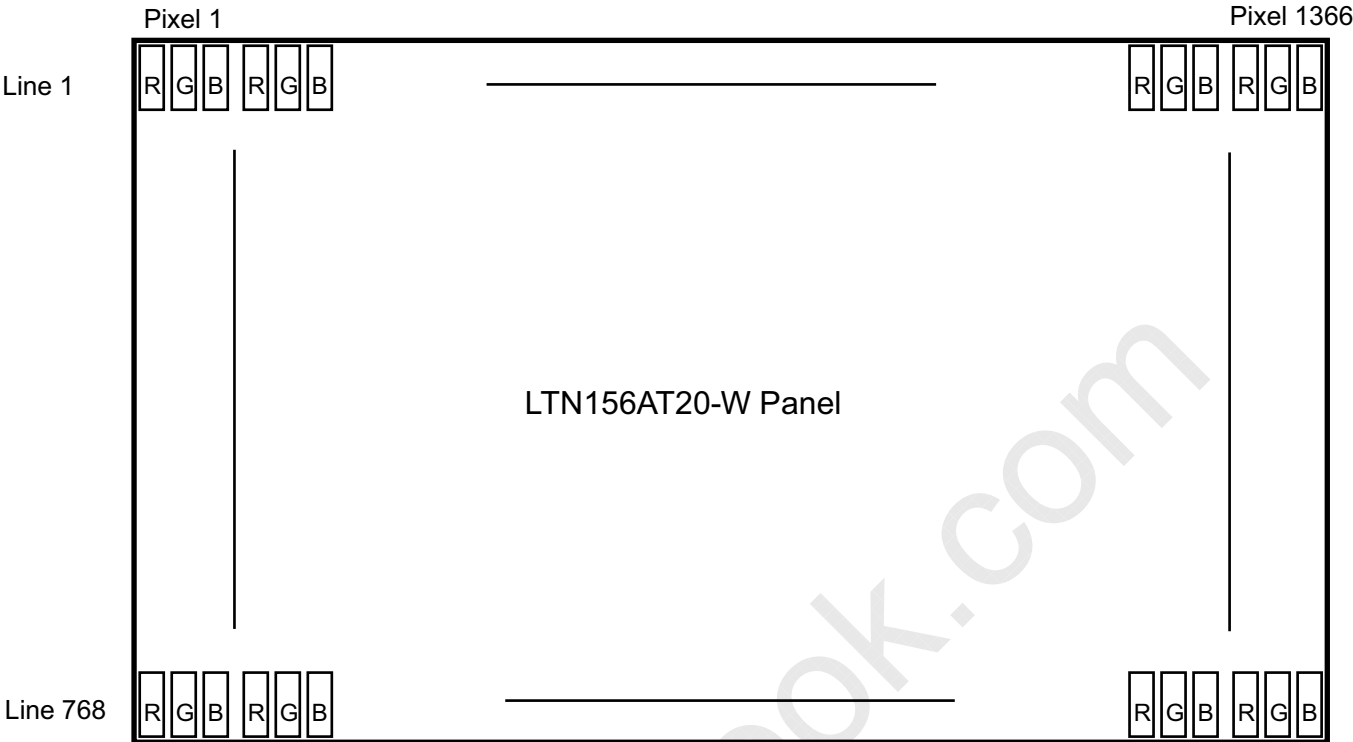
Rn: Red gray, Gn: Green gray, Bn: Blue gray (n=gray level)

Note 2) Input signal: 0 =Low level voltage, 1=High level voltage

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5.5 Pixel Format in the display



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## 6. INTERFACE TIMING

### 6.1 Timing Parameters

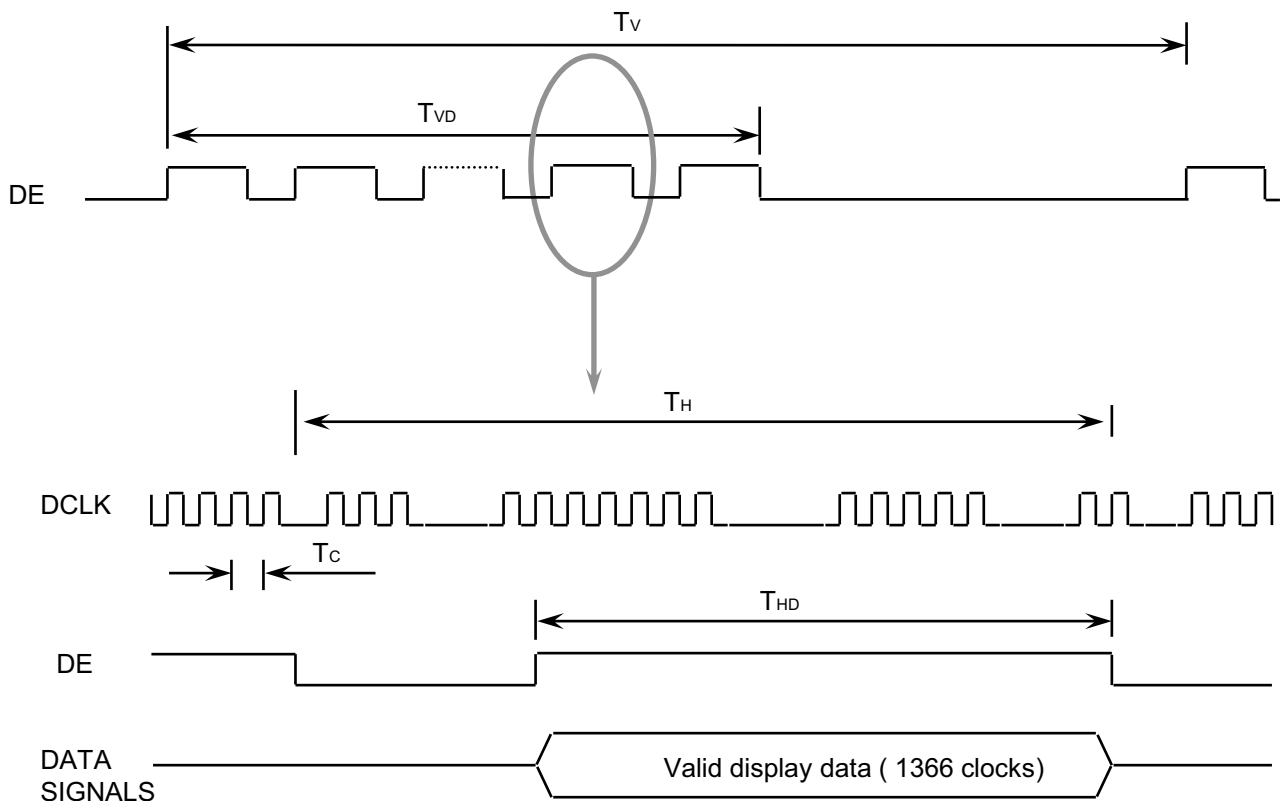
| Signal                         | Item           | Symbol | Min. | Typ. | Max. | Unit   | Note                |
|--------------------------------|----------------|--------|------|------|------|--------|---------------------|
| Frame Frequency                | Cycle          | TV     | 773  | 780  | 810  | Lines  | -                   |
| Vertical Active Display Term   | Display Period | TVD    | -    | 768  | -    | Lines  | -                   |
| One Line Scanning Time         | Cycle          | TH     | 1426 | 1526 | 1726 | Clocks | 2pixel/clock<br>(3) |
| Horizontal Active Display Term | Display Period | THD    | -    | 1366 | -    | pixels | -                   |

Note (1) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

Note (2) Internal VCC : 5.0 V

Note (3) DE signal have always the sample cycle.

### 6.2 Timing diagrams of interface signal

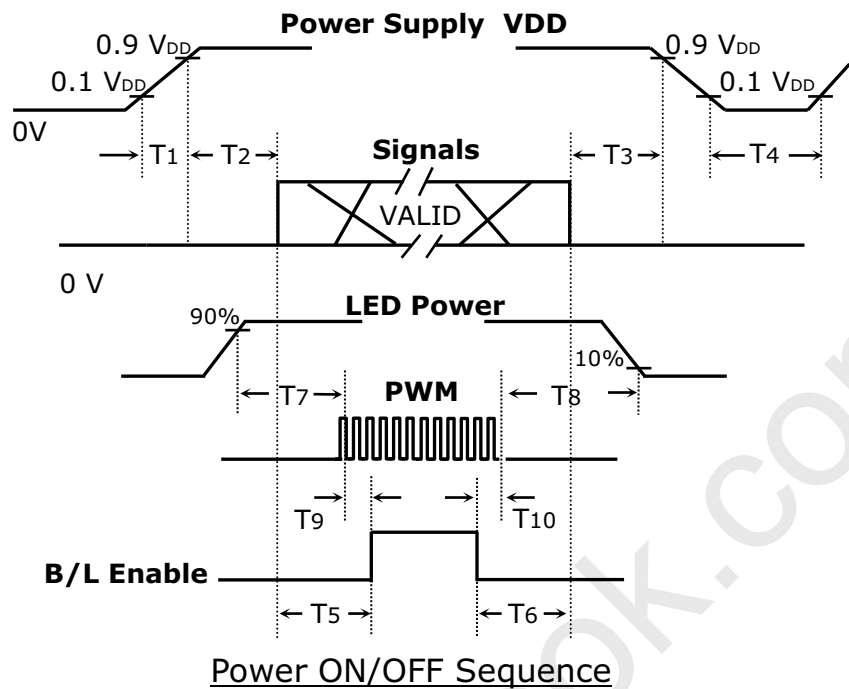


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6.3 Power ON/OFF Sequence

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: To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should be as the diagram below.



| Timing (ms)         | Remarks                                                       |
|---------------------|---------------------------------------------------------------|
| $0.5 < T_1 \leq 10$ | V <sub>DD</sub> rising time from 10% to 90%                   |
| $0 < T_2 \leq 50$   | Delay from V <sub>DD</sub> to valid data at power ON          |
| $0 < T_3 \leq 50$   | Delay from valid data OFF to V <sub>DD</sub> off at power OFF |
| $500 \leq T_4$      | V <sub>DD</sub> OFF time for Windows restart                  |
| $200 \leq T_5$      | Delay from valid data to B/L enable at power ON               |
| $200 \leq T_6$      | Delay from valid data off to B/L disable at power OFF         |
| $0 < T_7$           | Delay from LED driver power ON to PWM ON                      |
| $0 < T_8$           | Delay from PWM OFF to LED driver power OFF                    |
| $10 \leq T_9$       | Delay from PWM ON to B/L Enable ON                            |
| $0 < T_{10}$        | Delay from B/L Enable Off to PWM OFF                          |

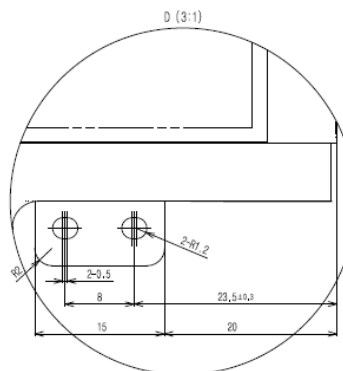
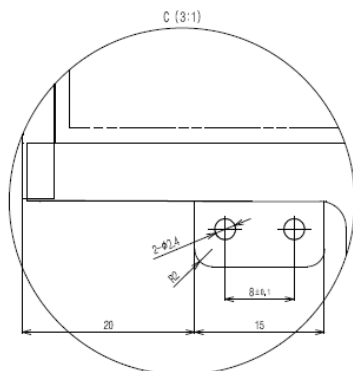
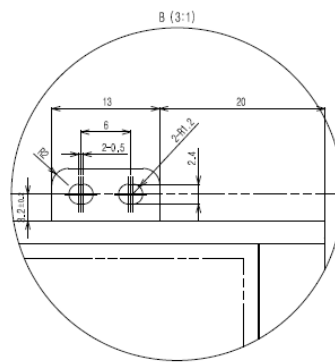
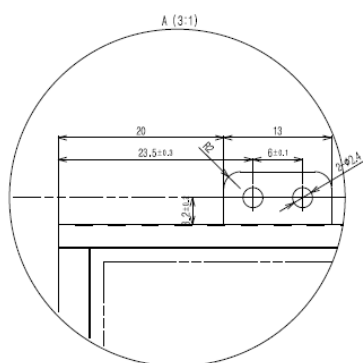
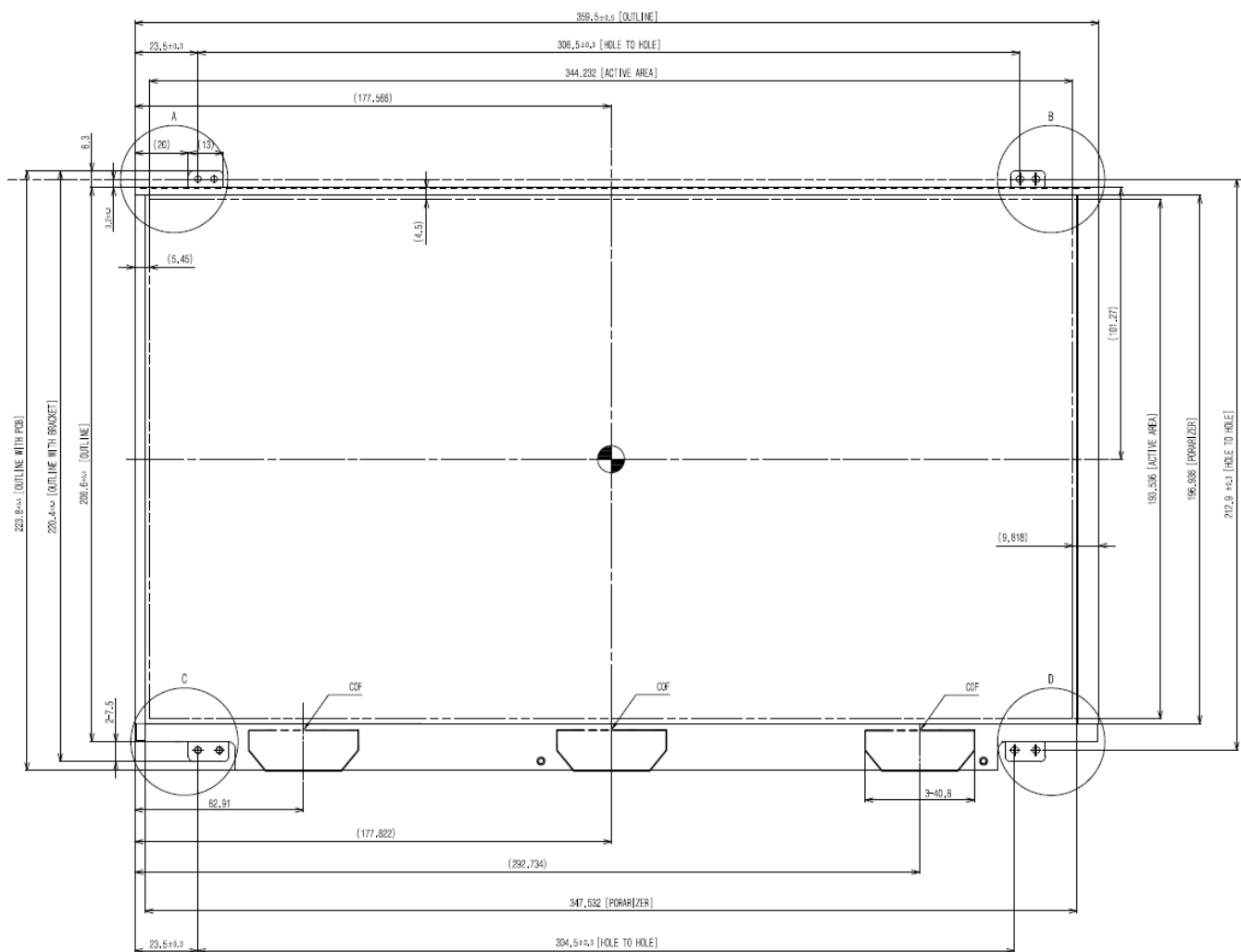
NOTE.

- (1) The supply voltage of the external system for the module input should be the same as the definition of V<sub>DD</sub>.
- (2) In case of VDD = off level, please keep the level of input signals on the low or keep a high impedance.
- (3) T4 should be measured after the module has been fully discharged between power off and on period.
- (4) Interface signal shall not be kept at high impedance when the power is on.

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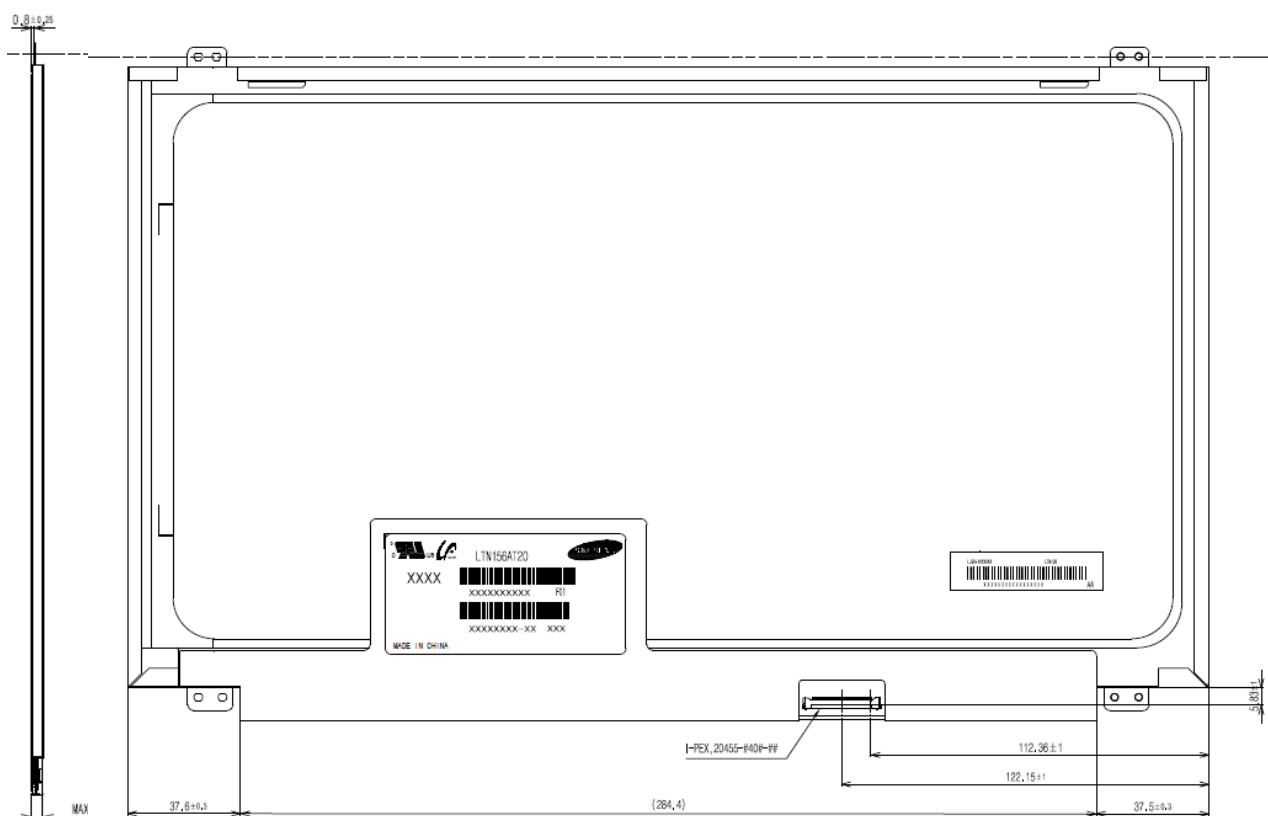
## 7. MECHANICAL OUTLINE DIMENSION

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## 8. PACKING

### 1. CARTON(Internal Package)

#### (1) Packing Form

Corrugated Cardboard box and Corrupad form as shock absorber

#### (2) Packing Method



Note (1) Total : Approx. 18 Kg

(2) Acceptance number of piling : 36 sets

(3) Carton size : 373(W) X 470(D) X 327(H)

(4) MAX accumulation quantity : 3 cartons

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## (3)Packing Material

| No | Part name                                           | Quantity |
|----|-----------------------------------------------------|----------|
| 1  | Static electric protective sack                     | 36       |
| 2  | Packing case (Inner box)<br>included shock absorber | 1set     |
| 3  | Pictorial marking                                   | 2 pcs    |
| 4  | Carton                                              | 1set     |

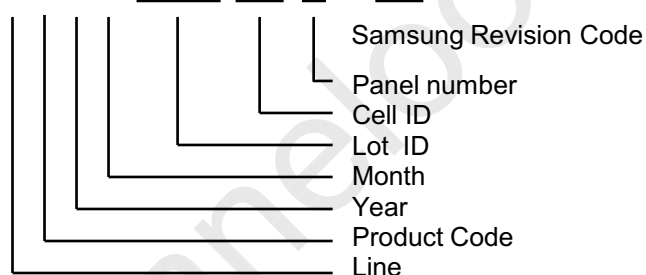
## 9. MARKINGS &amp; OTHERS

A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

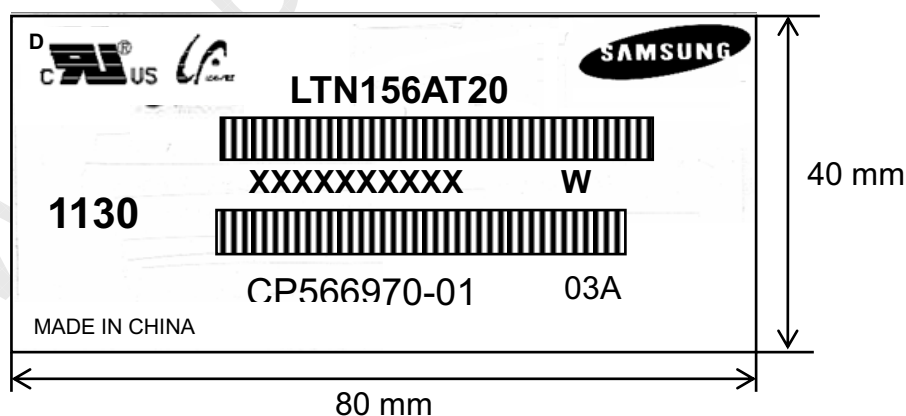
(1)Parts number : LTN156AT20

(2)Revision code : 3 letters

(3)Lot number : X X X X XXX XX X W



(5) Nameplate Indication ( Following example is only for reference )



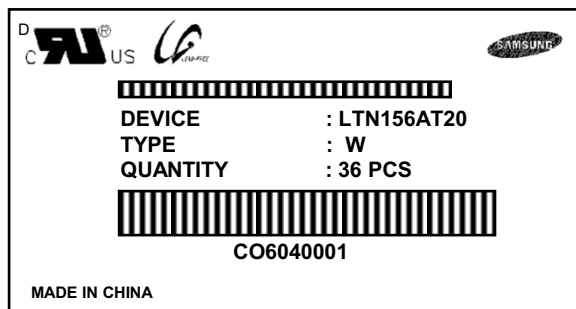
Parts name : LTN156AT20  
 Lot number : XXXXXXXXXX  
 Inspected work week : 1130(2011 year, 30th week)  
 Product revision Code : W  
 Customer's part number : CP566970-01 03A

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## (6) Packing small box attach



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## 10. GENERAL PRECAUTIONS

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### 1. Handling

- (a) When the module is assembled, It should be attached to the system firmly using every mounting holes. Be careful not to twist and bend the modules.
- (b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module.
- (c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.
- (d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.
- (e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
- (f) The desirable cleaners are water, IPA (Isoprophyl Alcohol) or Hexane.  
Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
- (g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.
- (h) Protect the module from static , it may cause damage to the C-MOS Gate Array IC.
- (i) Use fingerstalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (j) Do not disassemble the module.
- (k) Do not pull or fold the lamp wire.
- (l) Do not adjust the variable resistor which is located on the back side.
- (m) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (n) Pins of I/F connector shall not be touched directly with bare hands.

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## 2. STORAGE

We highly recommend to comply with the criteria in the table below.

| ITEM                | Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Min. | Max. |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|
| Storage Temperature | (°C)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 5    | 40   |
| Storage Humidity    | (%rH)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 35   | 75   |
| Storage life        | 12 months                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |      |
| Storage Condition   | <ul style="list-style-type: none"> <li>- The storage room should provide good ventilation and temperature control.</li> <li>- Products should not be placed on the floor, but on the Pallet away from a wall.</li> <li>- Prevent products from direct sunlight, moisture nor water; Be cautious of a build up of condensation.</li> <li>- Avoid other hazardous environment while storing goods.</li> <li>- If products delivered or kept in conditions of over the storage period of 3 months, the recommended temperature or humidity range, we recommend you leave them at a temperature of 20 °C and a humidity of 50% for 24 hours.</li> </ul> |      |      |

## 3. OPERATION

- (a) Do not connect, disconnect the module in the “Power On” condition.
- (b) Power supply should always be turned on/off by following item 6.3 “Power on/off sequence”.
- (c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.
- (d) The standard limited warranty is only applicable when the module is used for general notebook applications. If used for purposes other than as specified, Samsung is not to be held reliable for the defective operations. It is strongly recommended to contact Samsung to find out fitness for a particular purpose.

## 4. OTHERS

- (a) Ultra-violet ray filter is necessary for outdoor operation.
- (b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (c) Do not exceed the absolute maximum rating value. ( the supply voltage variation, input voltage variation, variation in part contents and environmental temperature, so on) Otherwise the module may be damaged.
- (d) If the module displays the same pattern continuously for a long period of time, it can be the situation when the image “sticks” to the screen.
- (e) This module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.

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## 11. EDID

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| Address<br>(HEX) | FUNCTION               | Value<br>HEX | BIN      | DEC | ASCII<br>or<br>Data | Notes                      |
|------------------|------------------------|--------------|----------|-----|---------------------|----------------------------|
| 00               | Header                 | 00           | 00000000 | 0   |                     | EDID Header                |
| 01               |                        | FF           | 11111111 | 255 |                     |                            |
| 02               |                        | FF           | 11111111 | 255 |                     |                            |
| 03               |                        | FF           | 11111111 | 255 |                     |                            |
| 04               |                        | FF           | 11111111 | 255 |                     |                            |
| 05               |                        | FF           | 11111111 | 255 |                     |                            |
| 06               |                        | FF           | 11111111 | 255 |                     |                            |
| 07               | ID Manufacturer Name   | 00           | 00000000 | 0   |                     | 3 character ID             |
| 08               |                        | 4C           | 01001100 | 76  | S<br>E<br>C         |                            |
| 09               | ID Product Code        | A3           | 10100011 | 163 | [B]                 | "SEC"                      |
| 0A               |                        | 42           | 01000010 | 66  | [4]                 |                            |
| 0B               | 32-bit serial no.      | 34           | 00110100 | 52  |                     |                            |
| 0C               |                        | 00           | 00000000 | 0   |                     |                            |
| 0D               |                        | 00           | 00000000 | 0   |                     |                            |
| 0E               |                        | 00           | 00000000 | 0   |                     |                            |
| 0F               | Week of manufacture    | 00           | 00000000 | 0   |                     |                            |
| 10               |                        | 00           | 00000000 | 0   |                     |                            |
| 11               |                        | 15           | 00010101 | 21  | 2011                | 2011                       |
| 12               |                        | 01           | 00000001 | 1   | 1                   | EDID Ver. 1.0              |
| 13               | EDID revision #        | 03           | 00000011 | 3   | 3                   | EDID Rev. 3                |
| 14               | Video input definition | 80           | 10000000 | 128 |                     |                            |
| 15               | Max H image size       | 22           | 00100010 | 34  | 34                  | 34 cm(approx)              |
| 16               | Max V image size       | 13           | 00010011 | 19  | 19                  | 19 cm(approx)              |
| 17               | Display Gamma          | 78           | 01111000 | 120 | 2.2                 | Gamma 2.2                  |
| 18               | Feature support        | 0A           | 00001010 | 10  |                     |                            |
| 19               | Red/green low bits     | 09           | 00001001 | 9   |                     | 10000111                   |
| 1A               | Blue/white low bits    | 25           | 00100101 | 37  |                     | 11111110                   |
| 1B               | Red x/ high bits       | 92           | 10010010 | 146 | 0.570               | Red x 0.570=<br>10010010   |
| 1C               | Red y                  | 57           | 01010111 | 87  | 0.340               | Red y 0.340=<br>01010111   |
| 1D               | Green x                | 54           | 01010100 | 84  | 0.330               | Green x 0.330=<br>01010100 |
| 1E               | Green y                | 8F           | 10001111 | 143 | 0.560               | Green y 0.560=<br>10001111 |
| 1F               | Blue x                 | 29           | 00101001 | 41  | 0.160               | Blue x 0.160=<br>00101001  |
| 20               | Blue y                 | 22           | 00100010 | 34  | 0.135               | Blue y 0.135=<br>00100010  |
| 21               | White x                | 50           | 01010000 | 80  | 0.313               | White x 0.313=<br>01010000 |
| 22               | White y                | 54           | 01010100 | 84  | 0.329               | White y 0.329=<br>01010100 |
| 23               | Established timing 1   | 00           | 00000000 | 0   |                     |                            |
| 24               | Established timing 2   | 00           | 00000000 | 0   |                     |                            |
| 25               | Established timing 3   | 00           | 00000000 | 0   |                     |                            |
| 26               | Standard timing #1     | 01           | 00000001 | 1   |                     | not used                   |
| 27               |                        | 01           | 00000001 | 1   |                     |                            |
| 28               | Standard timing #2     | 01           | 00000001 | 1   |                     | not used                   |
| 29               |                        | 01           | 00000001 | 1   |                     |                            |
| 2A               | Standard timing #3     | 01           | 00000001 | 1   |                     | not used                   |
| 2B               |                        | 01           | 00000001 | 1   |                     |                            |
| 2C               | Standard timing #4     | 01           | 00000001 | 1   |                     | not used                   |
| 2D               |                        | 01           | 00000001 | 1   |                     |                            |
| 2E               | Standard timing #5     | 01           | 00000001 | 1   |                     | not used                   |
| 2F               |                        | 01           | 00000001 | 1   |                     |                            |
| 30               | Standard timing #6     | 01           | 00000001 | 1   |                     | not used                   |
| 31               |                        | 01           | 00000001 | 1   |                     |                            |
| 32               | Standard timing #7     | 01           | 00000001 | 1   |                     | not used                   |
| 33               |                        | 01           | 00000001 | 1   |                     |                            |
| 34               | Standard timing #8     | 01           | 00000001 | 1   |                     | not used                   |
| 35               |                        | 01           | 00000001 | 1   |                     |                            |

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|    |                                       |    |          |     |        |                                                 |
|----|---------------------------------------|----|----------|-----|--------|-------------------------------------------------|
| 36 | Detailed timing/monitor descriptor #1 | 41 | 01000001 | 65  | 72.33  | Main clock= 72.33 MHz                           |
| 37 |                                       | 1C | 00011100 | 28  |        |                                                 |
| 38 |                                       | 56 | 01010110 | 86  | 1366   | Hor active=1366 pixels                          |
| 39 |                                       | A0 | 10100000 | 160 | 160    | Hor blanking=160 pixels                         |
| 3A |                                       | 50 | 01010000 | 80  |        | 4bit : 4bit                                     |
| 3B |                                       | 00 | 00000000 | 0   | 768    | Vertical active=768 lines                       |
| 3C |                                       | 16 | 00010110 | 22  | 22     | Vertical blanking=22 lines                      |
| 3D |                                       | 30 | 00110000 | 48  |        | 4bit : 4bit                                     |
| 3E |                                       | 30 | 00110000 | 48  | 48     |                                                 |
| 3F |                                       | 20 | 00100000 | 32  | 32     | H sync. Width=32 pixels                         |
| 40 | Detailed timing/monitor descriptor #2 | 25 | 00100101 | 37  | 2<br>5 | V sync. Offset=2 lines<br>V sync. Width=5 lines |
| 41 |                                       | 00 | 00000000 | 0   |        | 2bit : 2bit : 2bit : 2bit                       |
| 42 |                                       | 58 | 01011000 | 88  | 344    | H image size= 344 mm(approx)                    |
| 43 |                                       | C2 | 11000010 | 194 | 194    | V image size = 194 mm(approx)                   |
| 44 |                                       | 10 | 00010000 | 16  |        |                                                 |
| 45 |                                       | 00 | 00000000 | 0   |        | No Horizontal Border                            |
| 46 |                                       | 00 | 00000000 | 0   |        | No Vertical Border                              |
| 47 |                                       | 19 | 00011001 | 25  |        |                                                 |
| 48 | Detailed timing/monitor descriptor #2 | 00 | 00000000 | 0   |        | Manufacturer Specified (Timing)                 |
| 49 |                                       | 00 | 00000000 | 0   |        |                                                 |
| 4A |                                       | 00 | 00000000 | 0   |        |                                                 |
| 4B |                                       | 0F | 00001111 | 15  |        |                                                 |
| 4C |                                       | 00 | 00000000 | 0   |        | Value=HSPWmin / 2                               |
| 4D |                                       | 00 | 00000000 | 0   |        | Value=HSPWmax / 2                               |
| 4E |                                       | 00 | 00000000 | 0   |        | Value=Thbpmin / 2                               |
| 4F |                                       | 00 | 00000000 | 0   |        | Value=Thbpmax / 2                               |
| 50 |                                       | 00 | 00000000 | 0   |        | Value=VSPWmin / 2                               |
| 51 |                                       | 00 | 00000000 | 0   |        | Value=VSPWmax / 2                               |
| 52 | Detailed timing/monitor descriptor #3 | 00 | 00000000 | 0   |        | Value=Tvbpmin / 2                               |
| 53 |                                       | 00 | 00000000 | 0   |        | Value=Tvbpmax / 2                               |
| 54 |                                       | 1E | 00011110 | 30  |        | Thpmin=value*2 + HA pixelclks                   |
| 55 |                                       | B4 | 10110100 | 180 |        | Thpmax=value*2 + HA pixelclks                   |
| 56 |                                       | 02 | 00000010 | 2   |        | Tvpmin=value*2 + VA lines                       |
| 57 |                                       | 74 | 01110100 | 116 |        | Tvpmax=value*2 + VA lines                       |
| 58 |                                       | 00 | 00000000 | 0   |        | Module revision                                 |
| 59 |                                       | 00 | 00000000 | 0   |        | ASCII Data String Tag                           |
| 5A |                                       | 00 | 00000000 | 0   |        |                                                 |
| 5B |                                       | 00 | 00000000 | 0   |        |                                                 |
| 5C |                                       | 00 | 00000000 | 0   |        |                                                 |
| 5D | Detailed timing/monitor descriptor #3 | FE | 11111110 | 254 |        |                                                 |
| 5E |                                       | 00 | 00000000 | 0   |        |                                                 |
| 5F |                                       | 53 | 01010011 | 83  | [S]    |                                                 |
| 60 |                                       | 41 | 01000001 | 65  | [A]    |                                                 |
| 61 |                                       | 4D | 01001101 | 77  | [M]    |                                                 |
| 62 |                                       | 53 | 01010011 | 83  | [S]    |                                                 |
| 63 |                                       | 55 | 01010101 | 85  | [U]    |                                                 |
| 64 |                                       | 4E | 01001110 | 78  | [N]    |                                                 |
| 65 |                                       | 47 | 01000111 | 71  | [G]    |                                                 |
| 66 |                                       | 0A | 00001010 | 10  | [*]    |                                                 |
| 67 | Detailed timing/monitor descriptor #3 | 20 | 00100000 | 32  | [ ]    |                                                 |
| 68 |                                       | 20 | 00100000 | 32  | [ ]    |                                                 |
| 69 |                                       | 20 | 00100000 | 32  | [ ]    |                                                 |
| 6A |                                       | 20 | 00100000 | 32  | [ ]    |                                                 |
| 6B |                                       | 20 | 00100000 | 32  | [ ]    |                                                 |
|    |                                       |    |          |     |        |                                                 |
|    |                                       |    |          |     |        |                                                 |
|    |                                       |    |          |     |        |                                                 |
|    |                                       |    |          |     |        |                                                 |
|    |                                       |    |          |     |        |                                                 |

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|    |                                       |    |          |     |     |                          |
|----|---------------------------------------|----|----------|-----|-----|--------------------------|
| 6C | Detailed timing/monitor descriptor #4 | 00 | 00000000 | 0   |     | Monitor Name Tag (ASCII) |
| 6D |                                       | 00 | 00000000 | 0   |     |                          |
| 6E |                                       | 00 | 00000000 | 0   |     |                          |
| 6F |                                       | FE | 11111110 | 254 |     |                          |
| 70 |                                       | 00 | 00000000 | 0   |     |                          |
| 71 |                                       | 31 | 00110001 | 49  | [1] |                          |
| 72 |                                       | 35 | 00110101 | 53  | [5] |                          |
| 73 |                                       | 36 | 00110110 | 54  | [6] |                          |
| 74 |                                       | 41 | 01000001 | 65  | [A] |                          |
| 75 |                                       | 54 | 01010100 | 84  | [T] |                          |
| 76 |                                       | 32 | 00110010 | 50  | [2] |                          |
| 77 |                                       | 30 | 00110000 | 48  | [0] |                          |
| 78 |                                       | 2D | 00101101 | 45  | [-] |                          |
| 79 |                                       | 46 | 01000110 | 70  | [F] |                          |
| 7A |                                       | 30 | 00110000 | 48  | [0] |                          |
| 7B |                                       | 31 | 00110001 | 49  | [1] |                          |
| 7C |                                       | 0A | 00001010 | 10  | [^] |                          |
| 7D |                                       | 20 | 00100000 | 32  | [ ] |                          |
| 7E | Extension Flag                        | 00 | 00000000 | 0   |     |                          |
| 7F | Checksum                              | 0B | 00001011 | 11  |     |                          |

Samsung Secret